QTXCF8.42.1
Not Joint - Car. 5/20/1931

ELECTRIC LINE CROSSING PERMIT (Permanent) No. 49234 R. W. 28 12-N-20 W

COPY

NORTHERN PACIFIC RAILWAY COMPANY, hereinafter called the Railway Company, hereby grants to Puget Sound Power & Light Company, a Massachusetts corporation, of Seattle, Washington, hereinafter called the second party, the right to construct, maintain and operate an electric current line with the necessary poles, crossarms, wires, conduits and other fixtures appurtenant thereto across the right of way of the Railway Company along the course described as follows:

Intersecting the center line of the main track of the Railway Company's Lake Washington Belt Line in Section 29, Township 24 North, Range 5 East of the Willamette Meridian, in King County, Washington, near Quendall station, at a point therein distant 346 feet southerly, measured along said center line, from Mile Post 7 (which mile post is located 4635 feet northeasterly and northerly, measured along said center line, from the south line of said section).

This permission is granted upon the following terms:

1. The second party will pay a rental of Five and no/100 ($5.00) Dollars in advance for the full term hereof, also all taxes and assessments that may be levied or assessed against the improvements.

2. The electric wires and appurtenances shall be constructed and maintained in accordance with specifications contained in Exhibit "A" hereto attached and made a part of this instrument.

3. All cost of construction and maintenance shall be paid by the second party; the Superintendent of Telegraph of the Railway Company will decide what portion, if any, of the work will be done by the Railway Company, and for such portion the second party will pay the Railway Company the estimated cost before the work is done; if the actual cost exceeds the estimate, the second party will pay the additional amount when called upon; if the actual cost is less than the estimate, the Railway Company will repay the surplus.

4. Should the construction or maintenance of the electric line herein contemplated necessitate any change or alteration in the location or arrangement of any other electric wires or appurtenances located upon the right of way of the Railway Company, the cost of such change or alteration will be paid by the second party.

5. The Railway Company shall have the right at any time to judge of the necessity of repairs in the crossing wires or appurtenances and may make written request upon the second party to make such repairs as the Railway Company may deem necessary. If at any time it becomes necessary in the judgment of the Railway Company for reasons of safety or otherwise, to change the location, elevation or method of construction of the crossing wires and appurtenances, such changes will be made promptly by the second party upon request of the Railway Company within thirty days after such request and in such manner as the Railway Company shall direct.

6. The crossing wires shall be used for the sole purpose of conveying electric currents at a potential not to exceed 13,000 volts.

7. This permit shall not be transferred or assigned by the second party without the written consent of the Railway Company.

8. The second party agrees that the wires and appurtenances and the use of the same for conducting electric current shall not damage at any time the railroad or structures of the Railway Company, or the property of The Western Union Telegraph Company, or any other property upon the right of way, or be a menace to the safety of the Railway Company's operations or any other operations conducted on the right of way. The second party will indemnify and save harmless the Railway Company, The Western Union Telegraph Company, and every other owner of any property upon said right of way, from all loss or damage to property, from all loss or damage from interfering with operation and from injuries to persons occasioned by the wires and appurtenances or the electric current conducted thereon.

9. After the completion of the crossing wires and appurtenances or any subsequent repairs thereof the second party shall remove from the right of way of the Railway Company, to the satisfaction of the Superintendent of Telegraph of the Railway Company, all false work and the like used in the installation or repair work.

10. If the second party at any time shall cease to maintain and operate the said line or shall fail faithfully to perform every agreement of this instrument, the Railway Company may forthwith terminate this permit and may forthwith expel the second party from its premises, and at the end of the permit the second party will restore the premises of the Railway Company to their former state.

11. It is understood by the parties that said pole line will be in danger of injury or destruction by fire or other causes incident to the operation of a railway, and the second party accepts this permit subject to such dangers. It is therefore agreed, as one of the material considerations of this permit, without which the same would not be granted, that the second party assumes all risk of loss, damage or destruction to said pole line without regard to whether such loss be occasioned by fire or sparks from locomotive engines or other causes incident to or arising from the movement of locomotives, trains or cars of any kind, misplaced switches, or in any respect from the operation of a railway, or to whether such loss or damage be the result of negligence or misconduct of any person in the employ or service of the Railway Company, or of defective appliances, engines or machinery, and the second party shall save and hold harmless the Railway Company from all such damage, claims and losses.

12. In addition to complying with the attached specifications, the wires hereby permitted shall be constructed to comply with the laws of the State of Washington covering electrical construction.

D D

IN WITNESS WHEREOF the parties hereto have executed these presents this 20th day of May, 1931.

NORTHERN PACIFIC RAILWAY COMPANY,

By J. L. Watson
Right of Way Commissioner.

Witnesses to Signature of Permittee:

J. S. Roe

W. E. Best

PUGET SOUND POWER & LIGHT COMPANY

By Jeff L. Alexander
Manager

Northern Pacific Railway Company

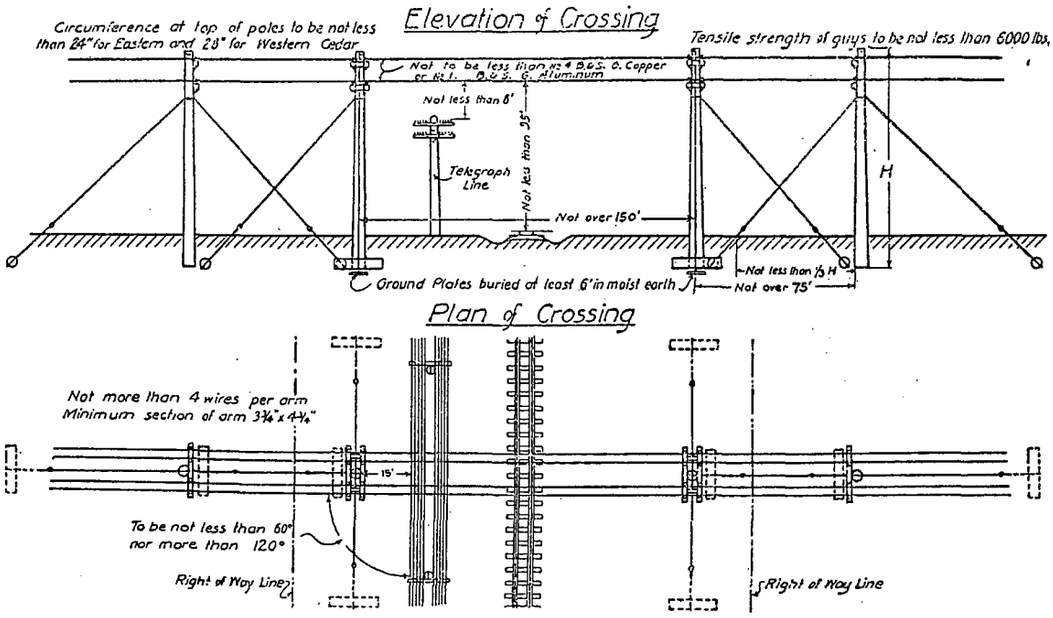
EXHIBIT "A"

SPECIFICATIONS FOR OVERHEAD CROSSING OF ELECTRIC WIRES CARRYING 5,000 VOLTS OR OVER.

These specifications cover the construction and maintenance of overhead electric wires crossing over or parallel to railroad right of way, tracks or lines of wires, where the voltage on the wires is 5,000 volts or over.

GENERAL PLAN OF CONSTRUCTION.

The general plan of construction of the electric line crossing shall be as indicated below.



1. Location of Poles or Towers.

(a) The poles or towers supporting the crossing span shall preferably be placed outside the Railway Company's right of way and in no case be placed further apart than one hundred and fifty (150) feet, unless specially authorized by the Superintendent of Telegraph of the Railway Company. When wood poles are used, the span immediately adjacent to the poles of the crossing span shall not be over seventy-five (75) feet.

(b) The poles or towers supporting the crossing span and the adjoining spans on each side shall be in a straight line and shall cross the railroad right of way as near at right angles as practicable. In no case shall the angle between the electric line and the Railway Company's tracks or pole line be less than sixty (60) degrees unless specially authorized by the Superintendent of Telegraph of the Railway Company.

(c) The poles or towers shall be located as far away from inflammable material or structures as practicable. Also, the poles or towers shall be placed so that they will not be nearer than fifteen (15) feet from the nearest wire of any other pole line on the railroad right of way.

(d) Side clearance shall not be less than eight (8) feet from the nearest rail of main line tracks nor less than six (6) feet from the nearest rail of sidings.

(e) Where the electric line must necessarily be constructed higher than and parallel to the telegraph line, and separated from the latter by a distance less than the height of the electric line poles, the construction shall conform to the requirements for the cross-over span as hereinafter specified. The requirements shall also apply to each span next adjacent to the portion above the telegraph line, unless the distance from the nearest telegraph wire to the topmost wire on the electric line poles at the end of the over-built section, is greater than one and one-half (1½) times the height of the topmost electric line wire from the ground.

2. Position and Clearance of Wires.

(a) The electric wires shall cross over the telegraph, telephone, or any other wires on pole lines on the railroad right of way.

(b) The electric wires shall not be less than thirty-five (35) feet above the rail or any part of the railroad right of way, under the most unfavorable conditions of temperature and loading.

(c) The electric wires shall clear any existing wires on pole lines on the railroad right of way, under the most unfavorable conditions of temperature and loading, by not less than eight (8) feet. The telegraph cross arms may be spaced fifteen (15) inches on centers at crossings in order to allow poles of minimum height to be used.

3. Signs.

If required by the Railway Company, warning signs of an approved design shall be placed on all poles and towers located on the Railway Company's right of way.

4. General. **DETAILS OF MATERIALS AND CONSTRUCTION REQUIRED.**

(a) It is desired to so construct the crossing of the electric line wires so that each portion of the line shall have sufficient strength to resist the maximum mechanical stresses to which it may be subjected, due allowance being made for a factor of safety suited to the material used.

(b) Obviously the maximum mechanical loads upon the construction of electric line will occur when the wires are coated with ice and subjected to a maximum wind velocity at right angles to the line at the minimum temperature.

(c) The maximum stresses in construction of the electric line shall be computed on the basis of a wind pressure of twenty (20) pounds per square foot of plane area, or twelve (12) pounds per square foot of projected area for cylindrical surfaces. These values are based upon a maximum actual wind velocity of seventy (70) miles per hour and are to be used in connection with the following coincident conditions:

1. The maximum coating of ice one-half (½) inch in thickness.
2. A minimum temperature of Zero (0) degrees Fahrenheit.

NOTE: In a few sections in the territory of the Northern Pacific Railway, the minimum temperature of Zero (0) degrees and the above ice formation are not encountered. The construction of the electric lines in such regions may, with approval of the Superintendent of Telegraph, be modified to meet the local climatic conditions. In no case shall the minimum temperature be taken above thirty (30) degrees Fahrenheit.

(d) The following sizes and strengths of material are figured and specified on the assumption of the electric wires and structures being subjected at the crossing of the railroad right of way with mechanical loads and stresses

as outlined above, and that the wires do not exceed in number or size as hereinafter specified, under Paragraph h 12-a.

(e) Every facility for the inspection of material and workmanship shall be furnished by the company constructing the electric line. All work shall be subject to the inspection and approval of the Superintendent of Telegraph of the Railway Company, and his interpretation of the drawings and specifications and his decision as to the quantity and quality of the work shall be final.

5. Towers and Poles.

(a) The poles supporting the electric wires across the railroad right of way shall preferably be of steel. Wood poles may be employed as hereinafter specified. The reinforced concrete poles may be employed under specifications furnished or approved by the Superintendent of Telegraph of the Railway Company.

(b) **Steel Towers or Poles.**

When steel towers or poles are used, they shall be designed sufficiently strong to carry the maximum load and stresses hereinbefore specified and conform to the following general specifications:

1. A factor of safety of three (3) shall be used in connection with the structural steel.
2. All structural steel shall conform to specifications for open-hearth railway bridge or medium steel, adopted by the Association of American Steel Manufacturers.
3. The structural steel shall be galvanized or painted.
4. The foundation for the steel towers or poles shall be concrete and specially designed so as not to over-turn.
5. Complete specifications will be furnished by the Superintendent of Telegraph for the construction of the steel towers or poles when necessary.

(c) **Wood Poles.**

When wood poles are used they shall conform to the following specifications:

1. A factor of safety of six (6) shall be used in connection with figuring the strength of all poles.
2. Eastern or Western cedar may be used.
3. Poles shall be of selected timber, peeled, free from defects which would decrease their strength or durability, and, in general, conform to the Northern Pacific Railway Company's pole specifications.
4. No Eastern cedar pole shall be used having a circumference at the top of less than twenty-four (24) inches and circumference measurement for the different lengths of poles less than shown in the following table:

Length of Poles	Circumference Six (6) Feet from Butt
35 Feet	43 Inches
40 "	47 "
45 "	50 "
50 "	53 "
55 "	56 "
60 "	59 "

5. No Western Cedar pole shall be used having a circumference at the top of less than twenty-eight (28) inches and circumference measurement for the different lengths than shown in the following table:

Length of Poles	Circumference Six (6) Feet From Butt
35 Feet	41 Inches
40 "	43 "
45 "	45 "
50 "	47 "
55 "	49 "
60 "	52 "
65 "	54 "

6. Setting Poles.

(a) Wood poles shall be set to the depths given in the following table:

Length of Pole	Depth in Ground	Depth in Solid Rock
35 Feet	6 Feet	4 Feet
40 Feet	6 "	4 "
45 "	6½ "	4½ "
50 "	7 "	4½ "
55 "	7½ "	5 "
60 "	8 "	5 "
65 "	8½ "	6 "

(b) Great care shall be taken in setting poles to secure firm foundations. Exposure to washouts shall be avoided. Preferably, the poles should not be set in sloping banks; but, if unavoidable, the depth of the hole shall be measured from the lowest side of the opening. When the slope of the bank is greater than 45 degrees, or where the bank is so soft that the pole may kick out, the pole shall be set one-half foot deeper than specified in the above table. Wherever ordinary methods do not provide a secure setting for poles, artificial foundations shall be used.

(c) Wood poles shall be provided with a grounded copper wire or an approved equivalent metallic strip placed on the side of the pole and extending to the top of the same and then extended down the opposite side to the top of the lowest cross arm. This grounded conductor shall be of sufficient conductivity to carry safely the maximum short circuit current. This grounded conductor provides lightning protection and, in the case of wooden poles, serves to prevent arching and setting fire to the pole in case an electric wire becomes detached from its insulator and rests against the side of the pole.

7. Pole Fittings.

The top of each pole shall be roofed. Gains shall be one-half (½) inch deep and of proper width for the cross arm used. The center of the upper gain shall be at least ten (10) inches below the apex of the roof.

8. Guys.

(a) The factor of safety used in connection with guys shall be three (3).

(b) Wooden poles supporting the crossing span shall be side guyed in both directions and be head guyed away from the crossing span. When there are from four (4) to six (6) wires, the poles of the crossing span shall be double side guyed or guy strand used having at least twice the breaking strength specified in Paragraph 8-d. The next adjoining poles shall be head guyed in both directions.

(c) Braces may be used on the poles instead of guys, but the length shall not be less than ten (10) feet shorter than the poles, in connection with which the braces are used. The butt of each brace shall be set at least six (6) feet in the ground and when used both as a push and pull brace, a cross log at least five (5) feet long and not less than eight (8) inches in diameter shall be attached to the butt of the brace by means of a cross arm bolt.

(d) Guys shall be galvanized or copper covered stranded steel cable, having a breaking strength not less than six thousand (6,000) pounds or galvanized rolled rods of equivalent tensile strength. All guys shall be anchor guys and shall be attached to galvanized anchor rods at least five-eighths (⅝) inches in diameter and eight (8) feet long.

(e) The anchor rods shall be fastened to anchor logs. Excavations for anchor logs shall be six (6) feet deep where practicable. When not practicable to obtain this depth, excavation shall be made not less than four (4) feet deep. The size of the anchor log shall correspond to depth of excavation according to the following table:

Depth of Excavation	Dimension of Anchor Logs	
	Length	Diameter
6 Feet	5 Feet	10 Inches
	7 "	7 "
5 "	5 "	16 "
	8 "	10 "
4 "	5 "	23 "
	8 "	14 "
	10 "	12 "

The length and width of excavation shall be made as small as possible, especially at the surface of the ground.

(f) In general, the method of anchoring, location for anchors and depth and character of setting shall be such as to render effective the full strength of the guy. Poles having a pull greater than twelve (12) inches shall be guyed. Guys shall be placed at a distance from the pole not less than one-third (⅓) the length of pole. Guys shall be attached to the pole so as to be below the electric wires and clear the same by at least three (3) feet. Guys shall be attached to guy rods by means of thimbles and three (3) bolt guy clamps. The end of the guy attached to the pole shall be wrapped twice around the pole, and fastened with a three (3) bolt guy clamp, the wrapping held in place on the back of the pole by the use of staples or their equivalent.

(g) Strain insulators are not required, but if these should be placed in guys, each strain insulator shall have a breaking strength not less than that of the guy in which it is placed. Every guy which passes over or under any electric wires, other than those carried upon the guyed pole, shall be so placed and maintained as to provide at all times a clearance of not less than two (2) feet between the guy and such electric wire.

9. Cross Arms.

(a) The factor of safety used shall be three (3) for steel arms and five (5) for creosoted wood arms. Steel cross arms shall be preferably used. In case wood cross arms are employed, they shall be treated with creosote or dead oil of coal tar in order to preserve them.

(b) **Steel Cross Arms.**

Steel cross arms shall be constructed out of at least one-fourth (¼) inch angle iron with angles at least two and one-half (2½) by three (3) inches and of sufficient length to provide the proper spacing of the wires as specified in Paragraph 12-b, and shall be galvanized so as to stand the four (4) immersion test. All steel cross arms shall be grounded.

(c) **Wood Cross Arms.**

Wood cross arms shall be at least three and three-quarters (3¾) inches by four and three-quarters (4¾) inches cross section and of sufficient length to provide the spacing of wires as specified in Paragraph 12-b, and shall be provided with grounded galvanized iron plates or grounded copper wires on their upper surfaces. No wood cross arm shall have more than four (4) wires placed on it; two (2) wires being placed on each side of pole. Plates shall not be less than one-quarter (¼) of an inch in thickness, and of a cross-sectional area not less than that of the ground wire. If copper wires are employed they shall be of sufficient conductivity to carry safely the short circuit current. Ground wires or plates shall be firmly attached to the cross arm.

(d) Double cross arms shall in all cases be used on each of the poles of the crossing span and on all poles on railroad right of way on which there is a pull of more than ten (10) feet. Each end of all double cross arms shall be provided with a five-eighths (⅝) inch space bolt or wood blocking between the arms securely fastened by a one-half (½) inch bolt through the cross arms and block.

(e) Cross arms shall be attached to poles by means of cross arm bolts having a diameter of five-eighths (⅝) inches of proper length in order to extend through the pole and cross arm, providing necessary length for nuts and washers.

(f) Cross arm braces having a cross section of at least one-fourth (¼) inch by one and one-fourth (1¼) inches and twenty-eight (28) inches long shall be used and fastened to the poles by lag screws having a diameter of at least one-half (½) inch and at least three and one-half (3½) inches long. Cross arm braces shall be attached to the steel or wood cross arms by the use of carriage bolts having a diameter of at least three-eighths (⅜) of an inch and of the proper length to correspond with the arms used.

All cross arm fittings, as cross arm bolts, braces, lag screws, carriage bolts, ground plates (if iron), etc., shall be galvanized to stand the four (4) immersion test.

10. Pins.

(a) Steel pins shall be used in all cases and have a factor of safety of three (3).

(b) The cross section of the pins used shall be at least five-eighths (⅝) of an inch.

(c) Pins shall be thoroughly grounded.

11. Insulators.

(a) Porcelain insulators shall be used in all cases and shall be sufficiently strong so that, when mounted, they will withstand without injury twice the maximum mechanical stress to which they will be subjected when the line conductors are attached to them.

(b) Insulators for line voltages of less than 9,000 shall not flash over at four times the normal working voltage, under a precipitation of water of one-fifth (⅕) of an inch per minute, at an inclination of forty-five (45) degrees to the axis of the insulator.

(c) Each separate part of a built-up insulator, for line voltages over 9,000, shall be subjected to the dry flash-over test of that part for five (5) consecutive minutes.

(d) Each assembled and cemented insulator shall be subjected to its dry flash-over test for five (5) consecutive minutes.

The dry flash-over test shall be not less than:

Line Voltage	Test Voltage
Exceeding 9,000 but not exceeding 14,000	65,000
Exceeding 14,000 but not exceeding 27,000	100,000
Exceeding 27,000 but not exceeding 35,000	125,000
Exceeding 35,000 but not exceeding 47,000	150,000
Exceeding 47,000 but not exceeding 60,000	180,000
Exceeding 60,000	3 times line voltage

(e) Each insulator shall be so designed that, with excessive potential, failure will first occur by flash-over and not by puncture. Each assembled insulator shall be subjected to a wet flash-over test, under a precipitation of water of one-fifth (⅕) of an inch per minute, at an inclination of forty-five (45) degrees to the axis of the insulator.

The wet flash-over test shall not be less than:

Line Voltage	Test Voltage
Exceeding 9,000 but not exceeding 14,000	40,000
Exceeding 14,000 but not exceeding 27,000	60,000
Exceeding 27,000 but not exceeding 35,000	80,000
Exceeding 35,000 but not exceeding 47,000	100,000
Exceeding 47,000 but not exceeding 60,000	120,000
Exceeding 60,000	Twice the line voltage

(f) Test voltages above 35,000 volts shall be determined by the A. I. E. E. Standard Spark-Gap Method.

(g) Test voltages below 35,000 volts shall be determined by transformer ratio.

(h) Where suspension insulators are used, each individual disc shall be provided with interlinked attachments so that in case the porcelain should be shattered, the conductor will remain mechanically attached to the cross arm.

12. Wires.

(a) Kind and Size.

The factor of safety for wires shall be two (2). The minimum sizes of wire used shall be No. 4 B. & S. gauge copper and No. 1 B. & S. gauge aluminum. Solid or stranded conductors may be used up to and including No. 00 in size; stranded wire shall be used for conductors larger than 00 in size. There shall be no joints in the conductors in the crossing or adjacent spans.

Cases where the number of wires exceed six (6), or where the size of wire is greater than No. 0000, will be considered special and the Superintendent of Telegraph will supply additional details, as to the necessary strength of structure, in order to carry the additional load.

(b) Separation of Wires.

The separation of the conductors for spans not exceeding one hundred and fifty (150) feet shall not be less than the following for different voltages used:

Voltage Between Wires	Minimum Separation On Centers	Voltage Between Wires	Minimum Separation On Centers
Under 12,500	2 Feet	30,000 to 39,000	4 Feet
12,500 to 19,000	2½"	40,000 to 59,000	5 "
20,000 to 29,000	3½"	60,000 and over	6 "

For spans exceeding one hundred and fifty (150) feet, the pin spacing should be increased, depending upon the length of the span and the sag of the conductors.

When supported by insulators of the disc or suspension type, the crossing span shall be dead ended at the poles, or towers, supporting the crossing span, so that at these poles, or towers, the insulators will be used as strain insulators.

The clearance in any direction between the conductors nearest the pole, or tower, and the pole, or tower, shall not be less than:

Line Voltage	Clearances
Not exceeding 14,000 volts	9 Inches
Exceeding 14,000 but not exceeding 27,000	15 "
Exceeding 27,000 but not exceeding 35,000	18 "
Exceeding 35,000 but not exceeding 47,000	21 "
Exceeding 47,000 but not exceeding 70,000	24 "

(c) Sag.

The copper or aluminum wires shall be put up at the crossing span and at the spans on either side and adjacent to the crossing span with sags depending on the length of span and the temperature, as shown in Northern Pacific Railway Company's standard table of sags.

(d) Attaching Wires.

The method of attaching the conductors to the insulators shall be such as to hold the wires under maximum loading to the insulators in case of shattered insulators, or wires broken or burned at insulators without allowing an amount of slip which would materially reduce the clearance specified in Paragraph 2-c.

At the poles forming the termini of the spans covered by these specifications, each conductor shall be so protected at the point of attachment to the insulator, that if the insulator breaks down electrically, the resulting arc will not burn the conductor. This may be accomplished by providing between the conductor and the insulator a metal cap which will interpose at least one-half (½) inch of metal between the line conductor and the head of the insulator. Also, the conductor shall be protected from an arc for a distance of not less than twenty-four (24) inches on each side of the center of the insulator head by a serving of wire or a sheet metal envelope not less than No. 6 B. & S. gauge in thickness.

The wire serving or sheet metal envelope shall be of the same kind of metal as the line conductor which it protects.

13. Ground for Ground Wires.

The ground wire shall be at least as large as any conductor on line and shall be soldered to a coil of scrap copper, or approved metal, so as to provide ample surface for a ground sufficient to carry off the short circuited current. The coils of wire or ground plates shall be buried at least six (6) feet below the surface of the ground in permanently damp earth. Three (3) bushels of coke or charcoal shall be placed about the coils or plates to insure permanent dampness. Ground wire shall be protected, if necessary, by wooden mouldings from the ground line to a point at least ten (10) feet above the ground.

14. MAINTENANCE.

All poles, cross arms, insulators, wires, guys and other parts and materials used in the structure of the wire crossing over the right of way of the Railway Company shall be periodically inspected and necessary repairs promptly made by the company to whom the pole line and wires belong.

All painted structural steel shall be repainted as often as necessary, in order to protect the metal from corrosion or rust.

Wood poles and cross arms shall be replaced before their strength falls below two-thirds (⅔) of the original strength.

Surrounding underbrush or grass or any inflammable material must be kept removed from wood poles for a sufficient distance so as to reduce the fire hazard to a minimum.

The condition and resistance of the grounds in connection with the poles of the crossing span shall be tested at least every six (6) months, and if there are any defects in ground wires or connections or the resistance of the ground measures more than twenty (20) ohms, these defects shall be immediately corrected.

The guys and anchors shall be maintained so that the guys are kept taut and serve the purpose for which they are intended.

The wires shall be kept up to the sag specified in the specifications.

Northern Pacific Railway Company

STANDARD TABLES FOR SAGS OF DIFFERENT KINDS AND SIZES OF COPPER AND ALUMINUM WIRES

Temperature Coefficients.

Copper ..... .0000096
Aluminum ..... .0000128

MINIMUM SAGS FOR STRANDED HARD-DRAWN BARE COPPER WIRES

Span in Feet

No. 4/0 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	In.	In.	Feet	Feet	Feet
—20	2	3	5	8	13	20	3.5	6	10
0	2	4	5	9	14	22	3.5	6.5	10.5
20	3	4	6	10	16	24	4	7	11.5
40	3	4	6	11	18	27	4.5	8	12
60	3	5	7	13	20	31	5	8.5	13
80	4	6	8	15	24	35	5.5	9	13.5
100	4	7	10	17	27	40	6	10	14.5
120	5	8	12	20	31	46	7	10.5	15

Span in Feet

No. 3/0 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	In.	In.	Feet	Feet	Feet
—20	2	3	5	8	13	21	4	7	12
0	2	4	5	9	15	23	4	7.5	12.5
20	3	4	6	10	17	25	4.5	8.5	13.5
40	3	4	6	12	19	29	5	9	14
60	3	5	7	13	22	33	6	9.5	15
80	4	6	8	15	25	38	6.5	10.5	16.5
100	4	7	10	18	29	43	7	11	16
120	5	8	12	21	34	49	7.5	12	17

Span in Feet

No. 2/0 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	In.	In.	Feet	Feet	Feet
—20	2	3	5	9	14	23	4.5	9	15
0	2	4	5	10	16	26	5	9.5	15.5
20	3	4	6	11	18	29	5.5	10	16
40	3	4	7	12	21	33	6	11	17
60	3	5	7	14	24	37	6.5	11.5	17.5
80	4	6	9	16	28	43	7	12	18
100	5	7	10	19	32	48	8	12.5	18.5
120	6	9	12	23	37	54	8.5	13.5	19.5

Span in Feet

No. 0 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	In.	Feet	Feet	Feet	Feet
—20	2	3	5	9	16	2.5	5.5	11.5	18.5
0	2	4	5	10	18	2.5	6.5	12	19
20	3	4	6	11	21	3	7	12.5	19.5
40	3	5	7	13	24	3.5	7.5	13	20
60	3	5	8	15	27	4	8	14	20.5
80	4	6	9	18	32	4.5	8.5	14.5	21.5
100	5	7	11	21	37	5	9	15	22
120	6	9	13	25	42	5	9.5	15.5	22.5

MINIMUM SAGS FOR SOLID HARD-DRAWN BARE COPPER WIRES

Span in Feet

No. 1 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	In.	Feet	Feet	Feet	Feet
—20	2	4	5	10	19	3	8	14.5	23
0	3	4	6	11	22	3.5	8.5	15	23.5
20	3	4	6	13	25	4	9	16	24
40	3	5	7	15	30	4.5	9.5	16	24.5
60	4	6	8	18	34	5	10	17	25
80	4	7	10	21	39	5.5	10.5	17	25.5
100	5	8	12	25	44	6	11	18	26
120	6	10	16	30	49	6	11.5	18	26.5

Span in Feet

No. 2 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	In.	Feet	Feet	Feet	Feet
—20	2	4	5	12	25	4	10.5	18.5	29
0	3	4	6	14	29	4.5	11	19	29.5
20	3	5	7	16	33	5	11.5	19.5	30
40	3	5	8	19	39	5.5	12	20	30.5
60	4	6	10	23	43	6.0	12.5	20.5	31
80	4	7	12	27	48	6.5	13	21	31
100	5	9	14	31	53	7	13	21.5	31.5
120	7	11	18	35	58	7.5	13.5	22	32

Span in Feet

No. 3 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet
—20	3	4	6	17	3	6	14	24	37.5
0	3	4	7	20	3.5	6.5	14.5	24.5	37.5
20	3	5	8	23	4	7	15	25	38
40	3	6	10	27	4.5	7.5	15	25	38
60	4	7	12	30	5	8	15.5	25.5	38.5
80	5	9	14	35	5.5	8.5	16	26	39
100	6	11	17	39	5.5	8.5	16.5	26	39
120	8	14	22	44	6	9	16.5	26.5	39.5

Span in Feet

No. 4 B. & S.

Temp. F. or less	100	125	150	200	250	300	400	500	600
	Sags								
	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet
—20	3	4	8	25	5	9	18	31	46
0	3	5	9	29	5.5	9	18.5	31.5	46
20	3	6	11	33	6	9.5	19	31.5	46.5
40	4	7	13	33	6.5	10	19	32	46.5
60	4	9	16	42	6.5	10	19.5	32.5	47
80	5	11	19	46	7	10.5	19.5	32.5	47.5
100	7	13	23	50	7.5	11	20	32.5	47.5
120	9	16	27	54	7.5	11	20.5	33	48

Span in Feet

No. 6 B. & S.

Temp. F. or less	100	125	150	200	250	300	400
	Sags						
	In.	In.	In.	Feet	Feet	Feet	Feet
—20	3	8	22	5.5	10	15	30
0	4	10	26	6.0	10	15	30
20	5	13	30	6	10.5	15.5	30.5
40	6	16	33	6	10.5	15.5	30.5
60	8	19	36	6.5	11	16	31
80	10	22	39	6.5	11	16	31
100	13	25	41	7	11.5	16.5	31
120	16	28	44	7	11.5	16.5	31.5

MINIMUM SAGS FOR STRANDED BARE ALUMINUM WIRE

Span in Feet

No. 4/0 B. & S.

Temp. F. or less	80	100	125	150	200	250	300	400	500	600
	Sags									
	In.	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet
—20	1	2	3	5	11	2.5	5	11	19	29
0	1	2	3	6	15	3	5.5	12	19.5	29.5
20	2	3	5	8	21	3.5	6	12.5	20.5	30
40	2	4	7	11	27	4.5	7	13	21	31
60	4	6	11	17	34	5	7.5	13.5	21.5	31.5
80	6	10	16	22	41	5.5	8	14	22	32
100	10	14	24	27	46	6	8.5	14.5	22.5	33
120	13	18	25	32	52	6.5	9	15	23	33.5

Span in Feet

No. 3/0 B. & S.

Temp. F. or less	80	100	125	150	200	250	300	400	500	600
	Sags									
	In.	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet
—20	1	2	3	5	12	3	5.5	13	22	33.5
0	1	2	4	6	17	3.5	6.5	13.5	22.5	34
20	2	3	5	8	24	4.5	7	14	23	34.5
40	2	4	7	12	31	5	7.5	14.5	23.5	35
60	3	5	11	18	38	5.5	8	15	24	35.5
80	6	9	16	23	43	6	8.5	15.5	24.5	36
100	10	13	20	29	49	6.5	9	16	25	36.5
120	13	17	25	33	54	7	9.5	16.5	25.5	37

Span in Feet

No. 2/0 B. & S.

Temp. F. or less	80	100	125	150	200	250	300	400	500	600
	Sags									
	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet	Feet
—20	1	2	3	6	2	5	8.5	16.5	28	42
0	2	2	4	8	2.5	5.5	9	17	28.5	42.5
20	2	3	6	12	3	6	9	17.5	29	43
40	2	4	9	18	3.5	6.5	9.5	18	29.5	43
60	4	7	14	24	4	7	10	18.5	29.5	43.5
80	7	12	19	29	4.5	7	10.5	19	30	44
100	10	16	24	33	5	7.5	11	19.5	30.5	44.5
120	14	19	28	38	5.5	8	11.5	20	31	44.5

Span in Feet

No. 0 B. & S.

Temp. F. or less	80	100	125	150	200	250	300	400	500
	Sags								
	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet
—20	1	2	4	9	3.5	7	10.5	21	36.5
0	2	3	6	14	4	7	11	21.5	36.5
20	2	4	8	20	4.5	7.5	11.5	22	37
40	3	6	13	26	5	8	12	22	37
60	5	10	18	31	5	8.5	12	22.5	37.5
80	8	14	23	35	5.5	8.5	12.5	23	38
100	12	18	27	39	6	9	13	23	38
120	15	21	31	43	6	9.5	13.5	23.5	38.5

Span in Feet

No. 1 B. & S.

Temp. F. or less	80	100	125	150	200	250	300	400	500
	Sags								
	In.	In.	In.	In.	Feet	Feet	Feet	Feet	Feet
—20	1	3	7	20	5	9	13.5	26.5	42.5
0	2	4	11	25	5.5	9	14	27	43.5
20	2	5	16	30	5.5	9.5	14.5	27	44
40	4	9	21	34	6	10	14.5	27.5	44
60	7	13	25	39	6.5	10	15	27.5	44.5
80	10	18	29	42	6.5	10.5	15.5	28	44.5
100	14	21	32	45	7	11	15.5	28	45
120	17	24	36	49	7	11	16	28.5	45

MINIMUM SAGS FOR COVERED SOLID SOFT COPPER WIRES

Span in Feet

No. 4 B. & S.

Temp. F.	60	80	100	125	150	200	250	300
	Sags							
	In.	In.	In.	In.	Feet	Feet	Feet	Feet
—20	3	7	17	35	5	9.5	16	23.5
0	3	8	19	37	5	10	16	24
20	4	10	21	39	5	10	16	24
40	5	12	23	41	5.5	10	16.5	24
60	6	14	25	43	5.5	10	16.5	24.5
80	8	16	27	45	5.5	10.5	16.5	24.5
100	10	17	29	46	6	10.5	16.5	24.5
120	11	19	30	48	6	10.5	17	24.5

Span in Feet

No. 6 B. & S.

Temp. F.	60	80	100	125	150	200	250
	Sags						
	In.	In.	In.	Feet	Feet	Feet	Feet
—20	7	21	38	5.5	8.5	16	26
0	9	22	40	6	8.5	16	26.5
20	10	24	41	6	8.5	16	26.5
40	12	25	42	6	9	16	26.5
60	13	26	43	6	9	16	26.5
80	14	27	45	6	9	16.5	26.5
100	15	29	46	6.5	9	16.5	26.5
120	17	30	47	6.5	9	16.5	27